PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference TS 1436 PCT	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/EP2004/052690	International filing date *(day/month/year)* 28.10.2004	Priority date *(day/month/year)* 30.10.2003
International Patent Classification (IPC) or national classification and IPC C10G5/02		
Applicant SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 7 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☒ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
30.08.2005	14.02.2006
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Cagnoli, M Telephone No. +49 89 2399-7576

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/EP2004/052690

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-5, 7-27	as originally filed
6	received on 23.05.2005 with letter of 19.05.2005

Claims, Numbers

1-24	as originally filed
25-28	received on 08.03.2005 with letter of 18.02.2005

Drawings, Sheets

1/1	as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☒ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☒ the claims, Nos. 1-28
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-28
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-28
Industrial applicability (IA)	Yes:	Claims	1-28
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

The amendments filed with the letter dated 19.05.2005 introduce subject matter which goes beyond the disclosure of the application as originally filed: the original documents of the application (description, claims, drawing) do not disclose that step (c) has to be performed in a particular way to obtain a desired cricondentherm of the lean gas stream (cf. claims 5-7).

Therefore according to Rule 70.2(c) PCT the present International Preliminary Examination Report shall be based on the previous set of claims on file, i.e. as the amendments of the claims have not been made.

Reference is made to the following document/s/:
D1: US-A-3 378 992
D2: DE-A-198 40 409

1. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 does not involve an inventive step in the sense of Article 33(3) PCT.

1.1. The document D1 is regarded as being the closest prior art to the subject-matter of claim 1 and discloses (see figures 1 and 2 and the related text) a process for removing contaminants from a natural gas stream, from which the subject-matter of claim 1 differs in that after a first gas/liquid separation step the gas obtained is further submitted to a second gas/liquid separation step.

The attention of the applicant is drawn to the fact that in D1 the natural gas stream is first passed through a gas/liquid separator and that claim 1 does not exclude this possibility. This particular aspect of the process of D1 has to be considered as included in claim 1.

1.2. The problem to be solved by the present invention may therefore be regarded as improving the removal of contaminants from the gas stream after the regeneration of the adsorbent.

1.3. Document D2 discloses (see for example column 4, lines 10-21 and figure 1) the same solution proposed in claim 1 of the present application in order to solve the same problem. therefore the proposed solution cannot be considered as involving an inventive step (Article 33(3) PCT)

2. The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claim 20 which therefore is also considered not inventive.

3. Dependent claims 2 to 19 and 21 to 28 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step because their additional subject-matter is either anticipated by the D1-D2 or rendered obvious by the available prior art.

4. Dependent claims 5 to 7 do not fulfill the requirements of Art. 6 PCT because they define their subject-matter by the result intended to be achieved instead of the technical features enabling the achievement of the claimed result. The claims are therefore unclear.

further contaminants are condensed into a liquid and separated off phase so that a lean gas is obtained.

In this way actually a better quality of the regeneration gas can be obtained than the original natural gas stream. So the regeneration gas is first enriched in contaminants, and then contaminants are removed so that overall the contaminants level is decreased.

Suitably, another part of the natural gas stream is contacted with a second adsorbent bed in adsorption mode, to obtain a purified gas stream.

When the lean gas stream is then contacted with the second adsorbent bed, together with the other part of the natural gas stream, a purified gas stream can be obtained that is of better quality than what is obtainable with the known process, due to the better quality of the lean gas that is recycled from regeneration. It has been found that this is a very efficient way to improve the quality of the purified gas, just sufficiently to obtain required specifications in many practical situations, without having to modify other parts of the process such as the adsorption step. The present invention moreover helps to minimize the fraction of the natural gas stream that has to be used for regeneration.

Suitably, the lean gas stream has a cricondentherm lower than that of the natural gas stream, preferably at least 10 °C lower, more preferably at least 15 °C lower, most preferably at least 20 °C lower.

In absolute terms, the lean gas stream suitably has a cricondentherm below 10 °C, preferably below 6 °C, more preferably below 0 °C, most preferably below -5 °C.

The purified gas stream obtained from the second adsorbent bed suitably has a cricondentherm below 10 °C,

25. The system according to claim 24, wherein the accelerated velocity inertia separator comprises means for inducing a swirling motion the fluid stream entering this separator, thereby causing the contaminants, in particular water and hydrocarbons, to flow to a radially outer section of a collecting zone in the stream.

26. The system according any one of claims 20-23, wherein the second gas/liquid separator comprises a refrigerator.

27. The system according to any one of claims 20-26, wherein the means for heating the first adsorbent bed comprises a heater for the first gas stream.

28. The system according to any one of claims 20-27, further comprising a third adsorbent bed arranged to receive the first gas stream prior to the first adsorbent bed.

18.02.2005

CS/TS1436FF

AMENDED CLAIMS

1. A process for removing contaminants from a natural gas stream, the process comprising the steps of:
(a) contacting part of the natural gas stream as a first gas stream at an elevated temperature with a first adsorbent bed in regeneration mode, to remove contaminants present on the first adsorbent bed, and to obtain a second gas stream that is enriched in contaminants compared to the first gas stream;
(b) submitting the second gas stream to a gas/liquid separation step comprising cooling the second gas stream to a temperature such that at least some contaminants begin to condense into a first liquid phase that is rich in contaminants, and separating the first liquid phase from the second gas stream to create a third gas stream; wherein the gas/liquid separation step forms a first gas/liquid separation step, and wherein the process further comprises
(c) submitting the third gas stream to a second gas/liquid separation step to obtain a second liquid phase that is rich in contaminants, and a lean gas stream having a cricondentherm lower than that of the natural gas stream.

2. The process according to claim 1, further comprising contacting another part of the natural gas stream with a second adsorbent bed in adsorption mode, to obtain a purified gas stream.

3. The process according to claim 2, wherein the lean gas stream is contacted with the second adsorbent bed together with the other part of the natural gas stream.

4. The process according to claim 2, wherein the lean gas stream is added to the purified gas stream.

5. The process according to any one of claims 1-4, wherein step (c) is performed in such a way that the lean gas stream has a cricondentherm at least 10 °C lower, more preferably at least 15 °C lower, most preferably at least 20 °C lower than that of the natural gas stream.

6. The process according to any one of claims 1-5, wherein step (c) is performed in such a way that the lean gas stream has a cricondentherm below 10 °C, preferably below 6 °C, more preferably below 0 °C, most preferably below -5 °C.

7. The process according to any one of claims 4-6, wherein the lean gas stream is added to the purified gas stream in such a way that the resulting gas stream has a cricondentherm below 10 °C, preferably below 6 °C, more preferably below 0 °C, most preferably below -5 °C.

8. The process according to any one of claims 1-7, wherein the cooling in step (b) is done against a temperature above water freezing temperature, in particular using a water cooler.

9. The process according to any one of claims 2-8 when dependent on claim 2, wherein the temperature of the second adsorbent bed is between 5 and 45 °C, preferably between 20 and 30 °C.

10. The process according to any one of claims 1-9, wherein the temperature of the first adsorbent bed is between 200 and 350 °C, preferably between 250 and 325 °C, more preferably between 275 and 310 °C.

11. The process according to any one of claims 1-10 wherein step (c) comprises cooling the third gas stream to a temperature that is below a temperature at which contaminants in the third gas stream will begin to

condense into a second liquid phase, and separating the second liquid phase from the third gas stream.

12. The process according to claim 11, wherein the third gas stream is cooled to a temperature below the cooling temperature in step (b), preferably to a temperature below 0 °C, more preferably to a temperature below -5 °C.

13. The process according to any one of claims 1-12, wherein the second gas/liquid separation in step (c) is effected by means of an accelerated velocity inertia separator.

14. The process according to claim 13, wherein the accelerated velocity inertia separator is a supersonic inertia separator and the fluid stream flows at supersonic velocity.

15. The process according to claim 14, wherein a swirling motion is induced to the fluid stream flowing at supersonic velocity, thereby causing the contaminants, in particular water and hydrocarbons, to flow to a radially outer section of a collecting zone in the stream.

16. The process according to claim 11, wherein the cooling of the third gas stream is effected by refrigeration.

17. The process according to claim 16 wherein a hydrate inhibitor, preferably methanol, is injected into the third gas stream prior to refrigeration.

18. The process according to any one of claims 1-17, wherein step (a) comprises

(a1) heating the first gas stream in a heating zone to obtain a heated first gas stream;

(a2) contacting the heated first gas stream with the first adsorbent bed in regeneration mode.

19. The process according to any one of claims 1-18, wherein the first gas stream is passed through a third

adsorbent bed in cooling mode, prior to being contacted with the first adsorbent bed.

20. A system for removing contaminants from a natural gas stream, the system comprising:

- a first adsorption bed arranged to receive part of the natural gas stream as a first gas stream, and provided with a means for heating the first adsorbent bed, which first adsorption bed has an outlet for a second gas stream
- a cooler for cooling the second gas stream;
- a first gas/liquid separator for separating the cooled second gas stream into a first liquid phase and a third gas stream; and
- a second gas/liquid separator for separating the third gas stream into a second liquid phase and a lean gas stream.

21. The system according to claim 20, further comprising a second adsorbent bed arranged to receive another part of the natural gas stream at a temperature at which contaminants are adsorbed, and having an outlet for a purified gas stream.

22. The system according to claim 21, wherein the second adsorbent bed is arranged to receive the lean gas stream together with the other part of the natural gas stream.

23. The system according to any one of claims 20-22, wherein the first gas/liquid separator comprises a cooler arranged to condense liquid at a temperature above the freezing point of water, and wherein the second gas/liquid separator is arranged to separate contaminants that condense at a temperature lower than 0 °C.

24. The system according to any one of claims 20-23, wherein the second gas/liquid separator an accelerated

velocity inertia separator, preferably a supersonic inertia separator.

25. The system according to claim 24, wherein the accelerated velocity inertia separator comprises means for inducing a swirling motion the fluid stream entering this separator, thereby causing the contaminants, in particular water and hydrocarbons, to flow to a radially outer section of a collecting zone in the stream.

26. The system according to any one of claims 20-23, wherein the second gas/liquid separator comprises a refrigerator.

27. The system according to any one of claims 20-26, wherein the means for heating the first adsorbent bed comprises a heater for the first gas stream.

28. The system according to any one of claims 20-27, further comprising a third adsorbent bed arranged to receive the first gas stream prior to the first adsorbent bed.